

James Webb Space Telescope Project

Continuous Risk Management Plan

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**National Aeronautics and
Space Administration**

**Goddard Space Flight Center
Greenbelt, Maryland**

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1.0 **INTRODUCTION**

This document establishes a Continuous Risk Management Plan (CRMP) for the James Webb Space Telescope (JWST) Project at the Goddard Space Flight Center (GSFC). This plan governs how technical, cost, schedule and other forms of risk will be determined, analyzed, managed and communicated. Risk management activities conducted by other National Aeronautics and Space Administration (NASA) organizations, and Contractors working on the JWST Project must be planned and conducted in a manner compatible with this Plan.

The remainder of this Section contains the purpose and scope of this document (subsection 1.1), governing and reference documents (subsection 1.2), definitions used (subsection 1.3), and high-level JWST risk policies (subsection 1.4).

1.1 **PURPOSE AND SCOPE**

The goal of risk management on the JWST Project is to identify risks and to manage the efforts and resources necessary to avoid occurrence of the risks. The purpose of this document is to describe the overall process, procedures, organizational roles, and the tool that will be used to support this effort.

The scope of the plan presented in this document is risk management across the entire JWST Project. This plan governs the management of risks that may be encountered during the formulation, design, implementation, and operation of the entire JWST System. The JWST System is itself comprised of the Launch, Observatory and Ground Segments and their constituent Elements and Subsystems. The scope of this Plan also includes risks associated with the use of Project and Contractor financial resources, facilities, procedures, equipment, and personnel that have been allocated to the JWST Mission.

The scope of risks addressed also include joint risks related to the use of dedicated facilities and resources at other NASA Centers and international agencies, such as the European Space Agency (ESA) and the Canadian Space Agency (CSA), which have entered into partnership with the JWST Project in support of the JWST Mission. Whereas such joint risks and proposed mitigations will be considered within the context of JWST Project risk management, and tracked within the JWST Project Risk Management database, the actual addressing of joint risks will be implemented with the respective partner Organization, in accord with existing agreements.

1.2 **APPLICABLE DOCUMENTS**

The latest NASA Risk Management Policies for Projects are stated in NASA Procedures and Guidelines, *NASA Project and Project Management Processes and Requirements* (NPG 7120.5), Section 4.2. These policies are elaborated in the NASA Integrated Action Team (NIAT) Report (see Section 1.2.2, Ref. 6). The governing document for this Plan is the *Risk Management GSFC Procedures and Guidelines* (GPG) 7120.4. The next two subsections list these and other reference documents.

1.2.1 NASA Documents

GPG 7120.4	Risk Management
JWST-PLAN-000702	JWST Project Management
JWST-RQMT-000634	Mission Requirements Document
JWST SOW-000635	JWST Statement of Work
NPG 7120.5	NASA Project and Project Management Processes and Requirements
NPG 8000.4	Risk Management Procedures and Guidelines
NPG 8715.3	NASA Safety Manual
SP-610S	NASA Systems Engineering Handbook

1.2.2 Non-NASA Documents

1. Carnegie Mellon University Software Engineering Institute, Continuous Risk Management Guidebook, 1996
2. Department of Defense Systems Management College, Risk Management Guide for DOD Acquisition, Fourth Edition, February 2001
3. Conrow, Edmund, Effective Risk Management – Some Keys to Success, American Institute of Aeronautics and Astronautics, Inc., 2000
4. Earth Observing Systems & Earth Explorers Projects Risk Management Plan, P. Siegerman, The Aerospace Corporation, Draft, September 2001.

1.3 DEFINITIONS

Acceptable Risk: Acceptable risk is the risk that is understood and agreed to by the project and GPMC sufficient to achieve the defined success criteria within the approved level of resources.

Note: Characterization of a **primary risk** as acceptable shall be supported by the rationale, with the concurrence of the GPMC, that all reasonable mitigation options (within cost, schedule, and technical constraints) have been instituted.

Fault Tree Analysis (FTA): A qualitative technique to uncover credible ways that a top event (undesired) can occur. The results of the FTA are documented in a fault tree, which is a graphical representation of the combination of faults that will result in the occurrence of an undesired top event.

Failure Modes and Effects Analysis (FMEA): Failure Modes and Effects Analysis – A procedure by which each potential failure mode of each element of a system is analyzed to determine the effects of the failure mode on the system and to classify each potential failure mode according to the severity of the effects.

Likelihood: A risk's probability of occurrence is generally referred to as the probability measure of that risk.

Mitigation Plan: An action plan devised to reduce a risk's exposure by either reducing its likelihood of occurrence and/or its impact. In the JWST Risk Management Tool (RMT), each mitigation plan will be entered as a data item for that risk.

Primary Risk: Risk having both high probability and high impact/severity.

Probabilistic Risk Assessment (PRA): A rigorous technical discipline used in complex technological applications to reveal design, operation, and maintenance vulnerabilities, to enhance safety and to reduce costs.

Problem: When a risk crosses the mitigation boundary, its probability has now become 100% and the risk has by definition become a problem. It is important not to refer to problems as risks. A risk that has occurred should be flagged and "Closed" in the database.

Risk: The combination of the likelihood that a project will experience an undesired event (e.g., safety mishap, environmental exposure, failure to achieve mission success criteria, cost overrun, schedule slippage, etc.) and the severity of the consequences of the undesired event, were it to occur.

Risk Board: A decision making group established by the Project Manager to make risk control decisions regarding JWST Risks.

Risk Control: The process of using risk tracking and other information to make decisions regarding funding support of significant risk mitigation actions, diversion of resources from one mitigation effort to another, etc.

Impact measures: Describes the cost, schedule, and/or technical performance consequences if the risk event does occur.

Risk List: Table in the Risk Database containing all risks. Also refers to a formal report that lists the title of all risks, their status and the responsible engineer in consecutive order. This second sense of "Risk List" is a formal International Standards Organization (ISO) Quality Record that the Project must maintain.

Risk Management: A process wherein the Project Manager leads the Project Team in identifying, analyzing, planning, tracking, controlling, and communicating the risks and the actions to handle them. Effective communication must occur within the Team and with management and customers. Risk management is driven by established success criteria and is a continuous, iterative process to manage risk in order to achieve safety and mission success.

1.4 JWST PROJECT RISK POLICIES, GROUND RULES, AND GUIDELINES

This subsection contains the policies, ground rules, and guidelines that have been used to construct this plan.

1.4.1 Policies

Risks (like requirements, budgets, schedules, etc.) are the responsibility of system segment, element, subsystem, and component managers, who will take actions to identify, assess and mitigate risks within their scope of control.

Risks at different levels within the JWST Project have different mask levels and are available for inspection in the risk database, subject to security restrictions similar to JWST documents. In other words, risks belong to the Project, just as requirements, budgets, and schedules do.

To support compliance with the International Traffic In Arms Regulations (ITAR), the JWST Risk Management Board (JRMB) shall control the access by the international partners to technical issues and associated technical data, to where there is a clear need to know; within technical areas supported by the responsibilities in the JWST Letter of Agreements (LOAs)/Memorandum of Understanding (MOU).

1.4.2 Ground Rules

A period of five (5) working days will be the goal for following the submission of a new risk will be reserved for the assigned manager to review it for wording and to determine its applicability to their product responsibility, before that risk becomes public. Once the risk is assigned, and its status is “open”, it becomes visible in the database.

1.4.3 Guidelines

1. The managers of the Integrated Science Instrument Module (ISIM), Observatory, and the Ground System (or a delegated representative) will each routinely present their open high-priority risks for management review (generally at Project monthly reviews) together with the status of the plans to address each risk.
2. An issue may arise at a monthly management review when a proposed risk mitigation appears to require additional resources beyond those already allocated for a given effort (such as a need for additional funds or schedule changes). Technical issues such as interface changes with another group may also arise. If these or similar risk issues arise at a monthly review, then such risks and their issues will be discussed later at a scheduled meeting of the JRMB. The status of the top Project risks will be reported at each Monthly Status Review (MSR).
3. It is anticipated that the Observatory, ISIM and Ground Systems organizations within the JWST Project, will each have their own internal risk management process which will consider individual risks before these are presented to Project management.
4. Any risk that involves a potential change to an interface (e.g., an interface between two different products) should be reviewed at the next higher-level risk board, up to and including the JRMB.

2.0 RISK MANAGEMENT PROCESS OVERVIEW

This section contains an overview of the risk management process that will be used on JWST. A concise statement of the life cycle of a risk, from identification through analysis, planning, tracking and control is provided. Finally, a summary is provided of the roles and responsibilities of key participants in the risk management process, together with a high-level overview of how risk management is integrated with other JWST Project management activities.

The *NASA Project and Project Management Processes and Requirements Procedures and Guidelines*, NPG 7120.5, specifies five risk management functions:

- Identify
- Analyze
- Plan
- Track
- Control

These five functions, which are displayed as a schematic relationship in Figure 2-1, in practice are necessarily overlaid by feedback loops and a continual process of documentation and communication, as depicted in Figure 2-2.

Given the size and complexity of the JWST Project, the key step in the JWST risk management process will generally be the risk control function, where risk management decisions can be made with information collected for this purpose regarding the current set of primary risks. The steps of identification, analysis and planning prepare concrete risk descriptions and plans to address each risk. These plans are then set in motion. It is at the control step that the ongoing progress of mitigation efforts is reviewed and a potentially large number of significant risks compete for scarce resources.

The following subsections describe how risk data is assembled and risk plans are undertaken in the process steps that lead up to the control step just described.

2.1 RISK LIFE CYCLE AND DATA FLOWS

Figure 2-2 presents a basic model of the risk management process. This process begins with Risk Management Plan in which the general practice of risk management is specifically tailored to the particular project, resources are allocated, a support organization is defined, and the risk management process is defined.

The other five functions are the “life cycle” of a risk, and in fact an individual risk can make one or more cycles among these functions in the order indicated. The data required and generated in each function of the process is summarized in Table 2-1. Each functional step of this process is discussed in the sections below.



Figure 2-1. Continuous Risk Management Model

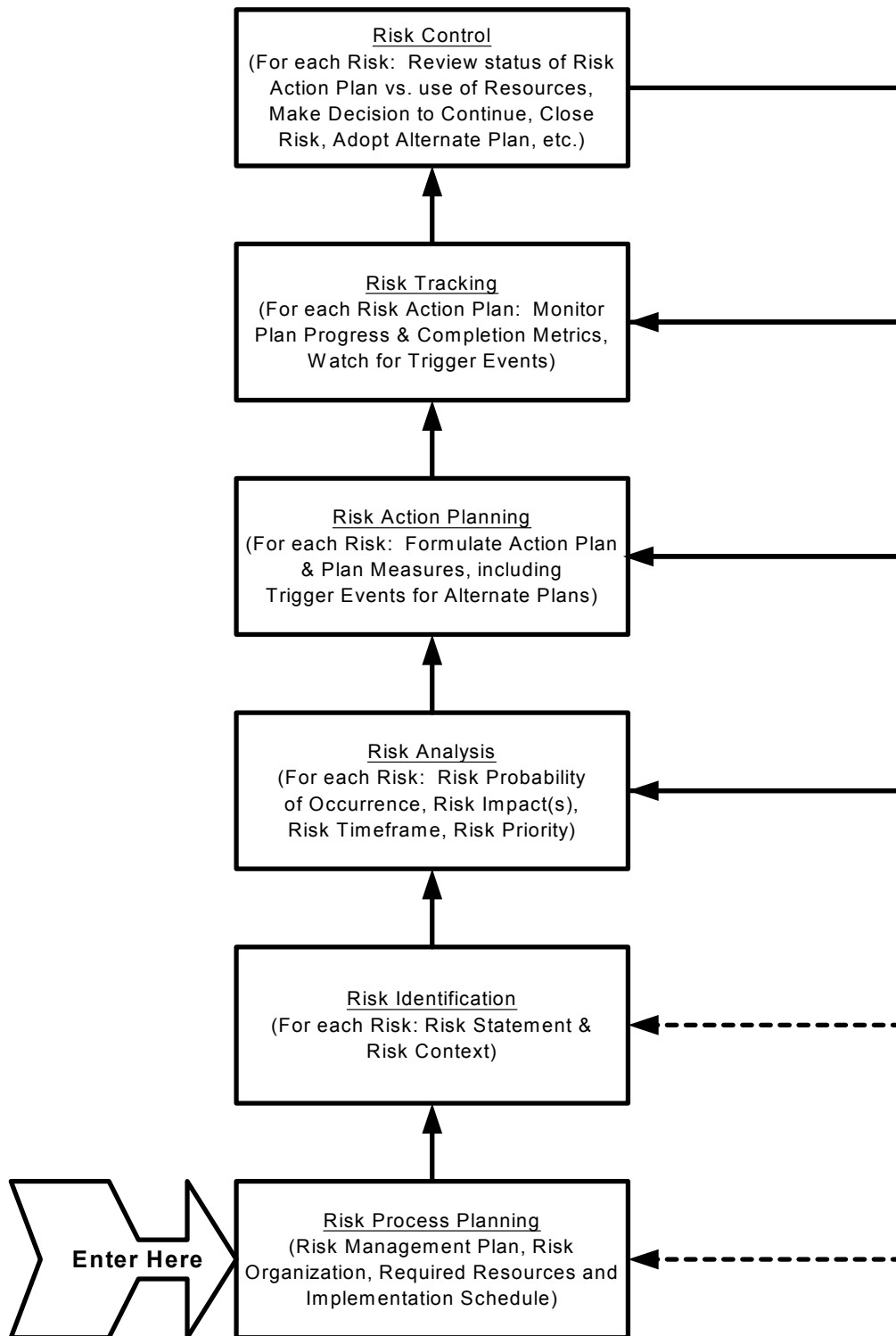


Figure 2-2. JWST Risk Process and Feedback Flows

2-3

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Table 2-1. Risk Data as a Function of Risk Process Step

Risk Step	Data Inputs	Data Outputs
Risk Implementation Planning	Project Constraints and Assumptions, Project Organization, Mission Concept, High-Level Requirements, Work Breakdown Structure, Top-Level Schedule, Policy Requirements	Risk Management Plan, Risk Organization, Risk Sponsorship Commitment, Risk Goals
Identification	Individual and Group Concerns, Project Data	Risk Contexts & Statements, List of Risks
Analysis	Risk Statement and List of Risks	Risk Contacts, Statements, Impacts, Probability, Timeframe, Classification and Priority Rank; Master List of Risks, Identification of Groups of Risks
Action Planning	Outputs of Analysis Step, plus Project Resources, Goals and Constraints (Cost & Schedule)	Risk Action Plans, Risk and Mitigation Metrics, Project Schedule and Budget revisions to reflect commitments to risk action plans
Tracking	Action Plans, Metrics, Risk Analysis	Status Reports regarding Risks & Mitigation Plans
Control	Outputs of Analysis and Monitoring Steps	Project Decisions, specifically, for each risk, whether to re-plan, close, invoke contingency, or continue tracking

2.1.1 **Identify**

The first function in the risk cycle is for an individual JWST team member to identify and document a risk concern and submit it to the risk database. Identifying a risk can occur in the context of a single kick-off brainstorming session or over a series of technical meetings where risk identification is routinely addressed. Various approaches are used to increase the probability that the set of risks identified is as complete as possible. Techniques that will be used by the JWST Project to increase the probability of detecting all significant risks include Fault Tree Analysis (FTA) and Failure Modes Effects Analysis (FMEA).

The most complete output of risk identification is the statement of each risk in an “IF condition; THEN consequence” format, together with the drafting of a descriptive context for each particular risk. Both the context and the risk statement should be written as completely as possible, with the criteria being that another person will be able to understand the risk from this information, even after some time has passed.

The risk statement in the IF-THEN format should have the two phrases separated by a semi colon, as in the following example:

IF there is no suitable off-the-shelf computer for use by ISIM **AND** a procurement and/or development effort is required to obtain a suitable computer; **THEN** a significant delay in obtaining sufficient quantities of the processor in question is possible, resulting in a negative schedule impact.

All identified risks are maintained in the Risk List of the JWST RMT in the internal website (<https://ngst1.hst.nasa.gov/>).

2.1.2 Analyze

The second function of the risk life cycle is risk analysis. In this function, the members of a JWST team consider new risks (or review older risks) in terms of several factors (see Sec. 3.0). The first factor is the likelihood of occurrence, generally referred to as the probability measure of the risk. The other factors are impact measure(s), which describe the cost, schedule, and/or technical performance consequences if the risk event does occur.

The probability measure could be the estimated probability of an external event, the estimated reliability of a component based on past measurements, the probability of a technology reaching a given maturity level at a specific time in the future based on its *current* maturity level, an analogous estimate of manufacturing maturity, or a value arrived at by brainstorming.

To reduce the subjective factor in making such assessments, the JWST risk process will utilize rating scales for each of these measures defined in advance – with each of five likelihood/consequence levels described in Tables 4-1 and 4-2.

The impact of a risk event can be to project cost, schedule and/or technical performance independently or simultaneously. For the same reason as above, in order to reduce uncertainty when multiple individuals judge the impact of a risk event, the JWST process will use pre-defined scales for each of the three impact dimensions (cost, schedule, and performance.) For any risk, it is the impact scale with the most severe rating that is used to determine the risk exposure (see Figure 4-1).

After the probability and the impact of the risk are separately analyzed, these two factors must be combined to arrive at a measure of the risk exposure itself. This can be accomplished using Figure 4-1, the Risk Priority Matrix. The JWST process will carry each relevant probability measure and each relevant impact measure forward for each risk. The intersection of the probability measure with the highest rating with the impact measure with the highest rating will be used to derive the priority of the risk for the next step, risk action planning.

Primary Risks (those having both high probability and high impact), will be under the focus of the JRMB and actions will be taken promptly to reduce or control those.

- The Risk Analysis step is completed by the assignment of risk priority, optionally grouping one or more risks into sets of similar risks that can be treated together in the next step, and the assigning of responsibility for each risk to a specific individual. Finally, the time frame is assigned to each risk. This is the time by which action must be taken to mitigate the risk.

2.1.3 Plan

Planning takes the input from the risk analysis function and, for the high and medium priority risks, formulates action plans to address them. The JRMB identifies the team that should be responsible for a risk. The Team Lead/Manager then assigns the risk to an individual who has the ability and knowledge to address the risk.

There are a number of possible actions that can be planned. A given Risk Action Plan may include trigger points at which decisions are planned, in advance, for example, regarding the initiation of a contingency plan.

- Risk Research: The assignee will investigate the risk until sufficient information is obtained to be able decide on further action;
- Risk Acceptance: If it is accepted that the risk may become a problem if it occurs and, no further resources are allocated to the risk by the JRMB. Before a Primary Risk is deemed acceptable, it will be supported by the rationale by the JRMB, with the concurrence of the GPMC, that all reasonable mitigation options have been instituted.

Note: Acceptance of a risk in the sense of this definition should not be confused with acceptance of a risk by a group lead when that lead determines that that risk falls within the scope of this group and can now be assigned to a team member.

- Risk Watching: The JRMB or the Team monitors the risk and its attributes for early warnings of critical changes in impact, probability, time frame or other aspects. The warnings are defined in terms of “triggers” that if they occur, indicate that action is warranted.
- Risk Avoidance: This strategy involves a change in the concept, requirements, specifications and/or practices by the project that reduce risk to an acceptable level. Simply stated, it eliminates the sources of high or possibly medium risk and replaces them with a lower risk solution.
- Risk Mitigation/Risk Control: These two terms refer to the same strategy – taking action by the JRMB and the assigned team to reduce the risk exposure, by reducing either the probability of occurrence, the impact, or both.
- Risk Transfer: Risk transfer may reallocate risk during the concept development and design processes from one part of the system to another, thereby reducing the overall system or lower-level risk, or re-distributing risks between the government and the prime contractor, for example, a function can be moved from hardware to software, or vice versa.

Part of risk planning is to choose one or more specific metrics to track for each risk during risk tracking.

2.1.4 Tracking

Risk tracking and monitoring is the collection of status data for risks with currently implemented action plans. The data is collected for general progress, but also specifically for the metrics identified in the Risk Action Planning step. The responsible risk team (see Section 3.0) has the responsibility for specifying such metrics, with review by the JRMB.

2.1.5 Control

Risk control is the heart of the risk management process. It is only after one or more risk action plans are actually in place that the effect on the JWST Project's overall risk exposure can be measured over time. The JRMB has the responsibility of risk control, by which they review the present allocation of resources to risk action activities, and consider whether to change that allocation. Or, if risk mitigation is not succeeding, the JRMB may move the funding for that mitigation to another high priority risk. Items that are no longer risks (for example, the initiating event can no longer happen, or the impact can no longer occur) can be closed.

Feedback loops exist in the Risk Management Process as shown in Figure 2-2. The JRMB at any time can request a tiger team to be convened to review one or more specific critical risks end-to-end. The PM should decide if any risk has reached a trigger level where a contingency plan needs to be invoked. The decision to close an identified risk in the JWST Risk Database should have the approval of the JRMB and will be documented in the Risk Tool database. A particular risk will have the formal approval of the PM, the person or team assigned that risk, and the person or team that identified that risk before it is closed.

The project will review and ensure that all risks are dispositioned before the FRR (Flight Readiness Review).

3.0 RISK MANAGEMENT ORGANIZATION AND ROLES

This section describes elements in the JWST organization that will participate in the Risk Management Process. The role of the teams in risk management is a central one and will be described first. The specific organizational elements that have been implemented to support the Risk Management Process consist of the JRMB, the Risk Coordinator, and the Risk Working Group (RWG). The risk process must also be coordinated with the work of other teams, as described below, specifically Project Management Team, the Planning and Scheduling Team, and the Systems Engineering Team (SET). This section also describes the role to be played in risk management by JWST customers, international partners, contractors, and sub-contractors.

At the highest level, the JRMB has oversight responsibility for the entire risk process. They serve as the senior management board which reviews risk identification and analysis data, as well as action plans. Later in the review process, they conduct the Risk Control function described in Section 2.1.5.

The Risk Coordinator supports the JRMB by ensuring that the overall risk process continues smoothly, and that all required data is collected and placed in the database in a timely manner. The Risk Coordinator also supports the integrity of the overall process by providing formal and informal training, and coaching in the risk process for all Project personnel.

The members of individual teams are the source of the expertise for individual risks as they are initiated and move through the system.

3.1 JWST RISK ORGANIZATION

The structure of the JWST risk organization is shown in Figure 3.1.

This organization has been referenced in Section 1.4, where the JWST risk management policies were stated. As depicted in Figure 3-1, it is envisioned that each of the three constituent offices within the JWST Project will create their own risk evaluation process, referred to in the figure as review boards. As stated in Section 1.4, risks will be presented by representatives of each of these organizations at the regular JWST Project monthly review. Risk issues will then be brought before the JRMB as the need arises.

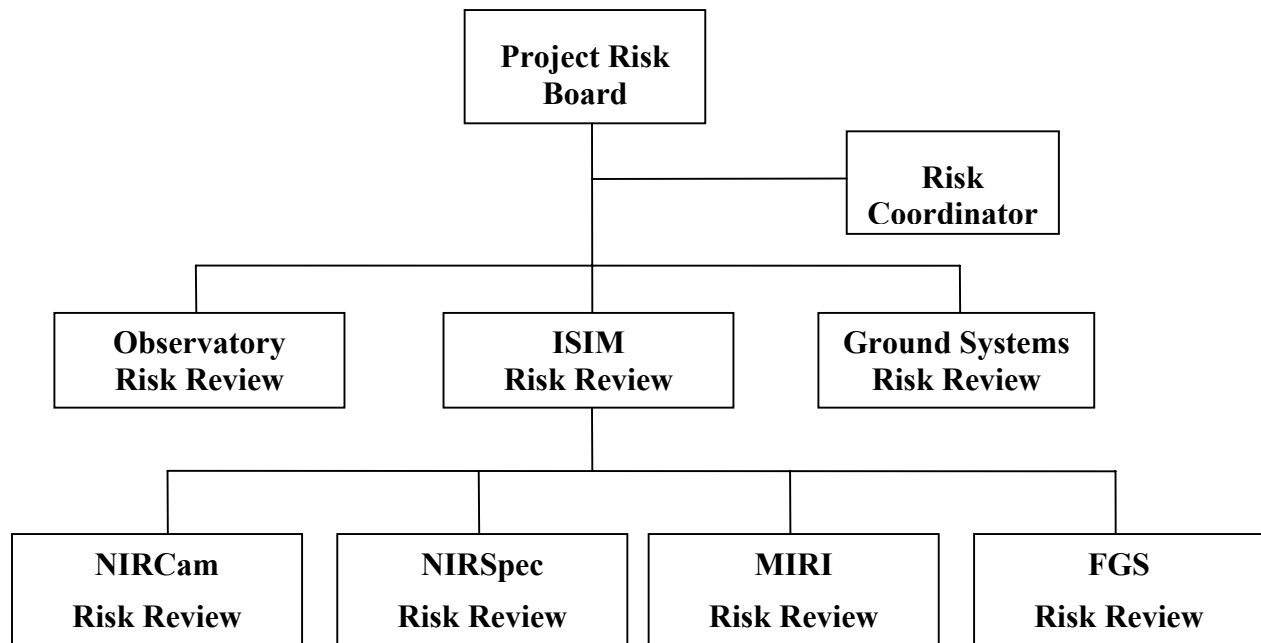


Figure 3-1. JWST Risk Organization

3.2 TEAMS

The critical expertise for risk identification, analysis and action planning lies with the JWST team as a whole and each individual team member operating within their specific discipline and local team affiliation(s). For this reason, these teams play the central role in the Risk Management Process on JWST. Risks are generally identified first at the team level and it is at this level that the best estimates of probability of occurrence and impact can be determined. It is the members of the team who will have the detailed context knowledge to be able to suggest risk mitigations or other forms of addressing specific risks.

There are two risk categories. The first category is those risks that the team expects to be able to address within the scope of their normal activities, using already allocated resources. These risks will be formally reported and tracked within the Project risk process (and risk database) to enable Project oversight.

The second category of risk is those which are not totally under the team's control; those that deal with interfaces with other JWST teams, with the outside environment, or with new technologies. The team cannot fully control the precipitating event for such a risk. These external team risks cross team boundaries and require the assistance and resources of one or more higher levels of the organization. All risks will be formally reported and tracked in the JWST Project Risk Database.

Each team has the flexibility to organize its risk management activities as it chooses, including, for example, approaches to risk identification and analysis. However, for purposes of standard communication outside the individual teams, both among teams and with Project Management, the use of common rating scales for probability and impact (see Figures 4-1 and 4-2), and the use of the JWST Project Risk Database to document the risks, will be required.

The Instrument teams are required to create and manage their own risk processes. As part of this process, they are required to identify the priority of each risk item using the likelihood and consequence levels defined in Figure 4-1 or equivalent. Risks identified by the Instrument boards are required to be brought forward to the ISIM Risk Board under two circumstances:

1. if they are categorized as high priority (red) risks using the definitions in Figure 4-1; and
2. if they affect interfaces to other JWST elements or teams.

3.3 JWST RISK MANAGEMENT BOARD

The JRMB is the senior authority for the Risk Management Process on the JWST Project. It has three primary responsibilities:

- Periodically review all risks defined for the JWST Project, and to accept recommended action plans to address these risks, revise such plans, or to propose action plans of its own at the Risk Board Meetings.
- To allocate available resources across the current set of baselined risks in order to support balanced risk reduction.

In terms of the steps of the Risk Process, the JRMB:

- Reviews risk **identification** and risk **analysis** presented by risk submitters, for selected high priority or otherwise critical risks
- Reviews and adjusts as needed risk **action planning** (mitigation plans, mitigation time frames, etc.) proposed by teams, for the same set of risks, and reassigned risks when necessary
- Performs the risk **control** function for the project as a whole (given risk **tracking** information, implements contingency plans, descope plans, etc., for individual risks)
- Initiates trade studies or other research regarding particular risks, as needed
- Sets policy regarding the **communication** of JWST risks to JWST customers, and
- Allocates Project resources as needed to implement risk mitigation activities in a balanced manner

The JRMB consists of the Project Manager, Deputy Project Manager, the Deputy Project Manager for Resources, the Senior Project Scientist, the Observatory Manager, the ISIM Manager, Ground Systems

Manager, Risk Coordinator, System Assurance Manager (SAM), and the Lead Systems Engineer. The JWST Project Manager serves as the Chair Person of the JRMB. Other subsystem leads will be invited to the Board Meetings as needed. The final authority for the membership of the JRMB resides with the JWST Project Manager.

A critical function of the JRMB is to reconcile risks which are mutually incompatible. For example, a risk mitigation process proposed by a subsystem may appear to increase the risk for another part of the project.

The JRMB role of allocating Project funds to mitigate high-priority risks is central to its responsibility. This allocation must be done in a balanced and comprehensive manner. That is, the allocation of resources must be done, as far as possible, to reduce each risk proportionally to its risk exposure, that is, the “product” of the probability and the impact for that particular risk.

3.4 RISK COORDINATOR AND RISK WORKING GROUP

This section describes the role of the Risk Coordinator and the functions performed by the RWG.

The Risk Coordinator is assigned to the Risk Management Process for the JWST Project and is responsible for a number of different functions:

- Maintaining JWST CRMP
- Implementing the CRMP
- Communicating the purposes of Risk Management and its general implementation details to all teams and team members
- Serving as the Secretary to the JRMB, by scheduling meetings, preparing the agenda for the meetings in terms of specific risks to be presented, and tracking action items as assigned by the Board
- Managing the Project Risk Database
- Providing risk training to team members as needed
- Presenting Project risk information at formal reviews
- Keeping JWST Project Management informed regarding current NASA risk policy and policy documents
- Coordinating the JWST risk process with risk and reliability professionals at GSFC and NASA-wide
- Arrange formal training of specific teams as required
- Attend meetings from time to time as a representative of the Project JRMB. The purpose of this attendance is to allow the Risk Coordinator to become familiar with the terminology, point of

view, operating constraints, and goals of each team on the Project, in order to better facilitate their formulation of their risk set and communicate it across the Project

- Providing risk tool training for all users

The Risk Coordinator also chairs the RWG that will meet as needed. The RWG membership is open to any member of the larger team who is interested in the details of the Risk Management Process. Its scope of discussion will include:

- Requirements for, and choice of, any new tools used in the Risk Management Process
- Effectiveness of the current risk management process, at the detailed level, and possible changes and/or improvements
- Risk data input templates and risk data reporting formats
- New developments and policy statements in the risk management field
- Rating scales for risk probability and risk impact
- Details of any current, high-level risks that are critical to the Project

Risk Managers for any contractor or sub-contractor are also invited to participate in the RWG.

3.5 PROJECT MANAGEMENT AND SYSTEMS ASSURANCE

JWST Project Management carries ultimate responsibility for Risk Management on the Project because it retains final responsibility for the allocation of Project resources across the Project. The high-level strategies of addressing the highest priority (and in many cases most visible) risks on the Project, such as the risks associated with new technology critical for the JWST mission concept, are one of the key responsibilities of Project Management. In general, this responsibility is delegated on a day-to-day basis to the JRMB, the Risk Coordinator, and effectively to each team.

The overall JWST Risk Management Process (and the Project's assessment of its highest-level risks) will be reviewed at each major external review throughout the Project.

The Systems Assurance Manager (SAM) is responsible for reviewing the CRMP and reviewing conformance of various JWST activities (in particular, integration and test) with quality standards.

3.5.1 Project Communication Responsibilities

Ongoing communications concerning JWST risk management include:

- Regular communication of the JWST “Top Ten” issues to Code 400 and GSFC Center Management

- Description of Science risks and related risk exposures to various elements of the Science Community, including specifically constituted JWST Science Committees
- Formal risk presentations at external and internal reviews
- Availability of detailed risk information to all members of the Project Team
- Requires all Project Team members to contribute risk concerns, reinforced by consistent and effective follow-through
- Involving contractors, sub-contractors, organizations at other Centers, and international partners in the Risk Management Process.

The JRMB will assign specific individuals to specific communication responsibilities in connection with those described in this chapter, and others as needed.

3.5.2 Standard Practices and Risk Management

Standard management and engineering practices (such as reliance on budgets, planning, peer reviews, formal requirements development and traceability through formal integration and test) are each present in the tool of their respective professions because they address certain failure modes that have been observed and carefully analyzed on past projects. Each of these standard practices are to some extent risk-reduction approaches which are now incorporated into the routine way the aerospace business is done. These practices must be carried out conscientiously and systematically to be truly effective – not merely as a check-the-box step. There is always a probability that the “generic” risks that were originally the motivation for any particular standard practice in the first place may “re-appear” on the Project.

3.5.3 Descope Plan

In case risk mitigation cannot be accomplished due to limited resources (cost, schedule, workforce) the PM and DPM will have a descope plan. The plan would allow solutions to resource problems while still permitting the project to meet the critical project objectives.

3.5.4 Reliability and Safety

FTA and FMEA will be performed to address both mission failures and degraded modes of operation Which will be expanded throughout the mission. Comparative numerical reliability assessments such as PRA will be used to identify the elements of the design that are the greatest detractors of system reliability.

3.6 PLANNING AND SCHEDULING

Planning and scheduling activities are integral to risk management. Risk action plans must be incorporated into the appropriate schedules. Decision points in an action must also appear on the schedule. One test of a Project's commitment to comprehensive risk management is the full articulation of risk action planning at all levels of the Project's schedules. Similarly, the financial and personnel resources required for risk action plans must also be incorporated into the Project plans.

A Risk Profile in Figure 3-6 shows the technical as well as programmatic risks over the life of the project showing major milestones. The Risk profile will be upgraded regularly to reflect the actual changes in risk and explanations for these changes will be annotated on the profile for briefing at major milestone meetings.

3.7 SYSTEMS ENGINEERING

The Systems Engineering Team (SET) plays a critical role in risk management. The SE Manager serves as a member of the JRMB, representing all elements under SET and interacting with other member representatives.

The SET is responsible for:

1. Maintaining the configured requirements for the Project. Just as these requirements are hierarchical and high-level requirements are allocated to lower-level functional areas for their implementation, as stated earlier, risks have an inherent hierarchical nature as well.
2. Performing trade studies of alternate technologies and their associated performance parameters. Such studies will be required for evaluating certain risk action plans.
3. Providing discipline engineers to assist in the review, interpretation and detailed planning for risk mitigations.
4. Planning and managing reserves at the System, Segment and Subsystem level for mass, power, volume, and other parameters. These reserves are themselves a generic risk mitigation, and can also be "spent" after careful review during making specific risk trades.
5. Assigning Systems Engineers to each Segment and Element (and also lower level subsystems as required). These engineers, together with discipline lead engineers, coordinate and integrate the requirements, design and implementation, including integration and test, for all levels of the System. These individuals also participate in the identification and development of interface requirement documents (IRDs) and interface control documents (ICDs). All of these activities provide fertile ground for risk identification across the entire JWST Project, as well as providing insight into potential risk actions plans, some of which will cut across team and/or engineering discipline boundaries.

JWST Risk Profile Schedule / Cost & Mission Risk

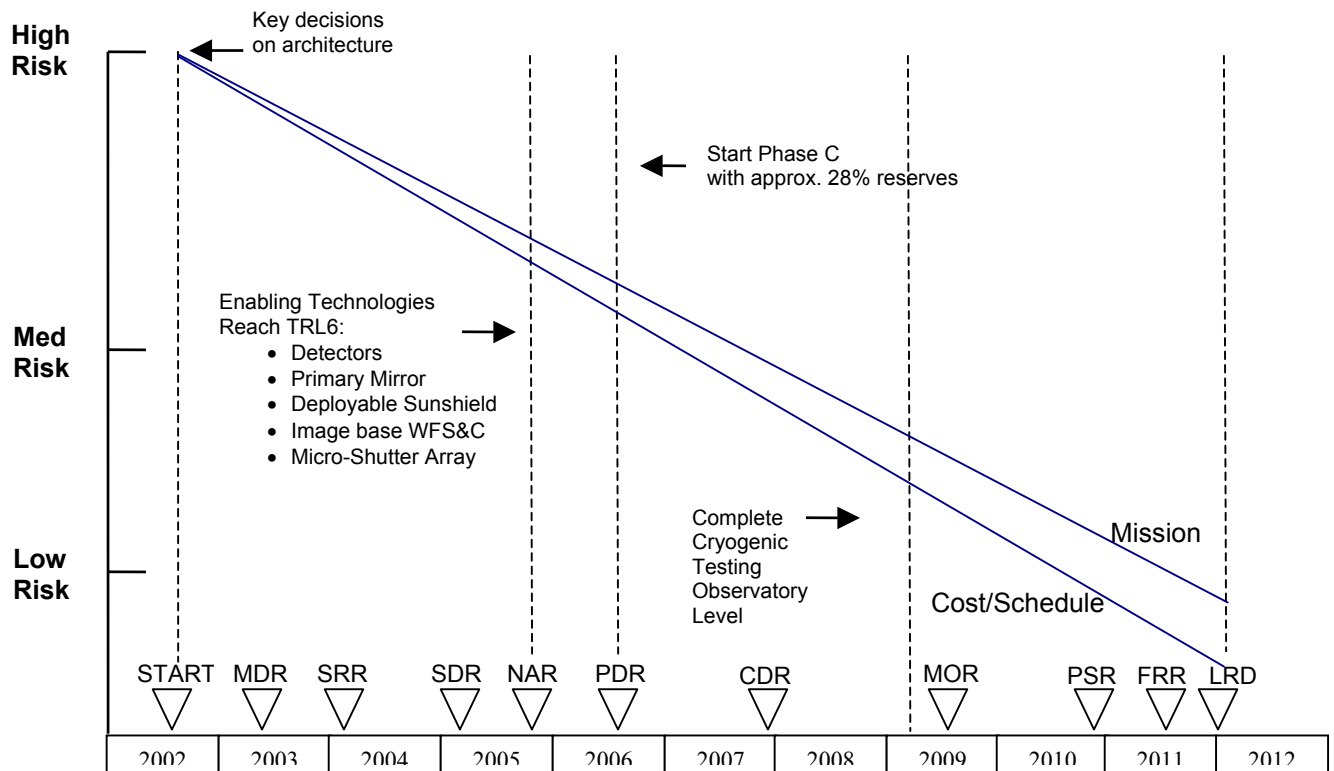


Figure 3-6. JWST Risk Profile

3.8 JWST CUSTOMERS

JWST customers constitute significant participants in the JWST Risk Management Process. These customers include NASA Headquarters (HQ) and its sub-organizations, GSFC and Project Directorate Management, the Science community as a whole, its organized bodies, and the Public. Customers can submit risk inquiries formally (for example, at reviews) or informally, and can submit risk actions suggestions, and also participate in the Risk Control Process. This communication process will be optimally supported because the JWST Risk Management Process will always be able to provide, on short notice, concise, up-to-date risk data. The decision history of particular critical risks is an important element of this data.

3.9 INTERNATIONAL PARTNERS

The scope of risks addressed by the JWST Project will include joint risks related to the use of dedicated facilities and resources at the ESA and the CSA. The exact process for reviewing such joint risks and deriving appropriate joint risk action will be documented in this document after the respective MOUs are established. These negotiations also will be implemented (with the respective partner Organization) in accord with any pre-existing agreements. JWST Project will work with ESA to address Launch Vehicle Risks.

3.10 CONTRACTORS AND SUBCONTRACTORS

The members of each Contractor's staff will be represented and participate in all risk management efforts as needed across the Project. In addition, the Contractors will report on their overall risk assessments and other risk management activities at monthly reviews and other venues. The use of standard RM rating scales (Section 1.2.2, Ref.1) and similar database tools will be essential to coordinating these activities. All of which must provide consistent and timely risk information to the JWST Project.

3.11 RISK MANAGEMENT TRAINING

Senior JWST Project Management will obtain formal training in Continuous Risk Management (CRM). All element and subsystem managers will be trained by the Risk Coordinator on the use of the JWST RMT. The same training will be made available to all JWST personnel.

3.12 ROLES AND RESPONSIBILITIES

Who	Responsibilities
Individuals	Software/Hardware engineers, testers, leads, and project manager <ul style="list-style-type: none">• identify new risks• estimate probability, impact, and timeframe• classify risks• recommend approach and actions• track risks and mitigation plans (acquire, compile, and report)
Teams Leads	<ul style="list-style-type: none">• ensure accuracy of probability/impact/timeframe estimates and the classification• review recommendations on approach and actions• build action plans (determine approach, define scope & actions)• report their Top N risks and issues to the project manager• collect and report general risk management measures/metrics

Who	Responsibilities
JRMB PM, DPM, MSE, Program Scientist, etc	<ul style="list-style-type: none">• Reviews risk information from all technical leads• reprioritizes all risks to determine Top 20% risks in each area• Accepts, revises or proposes action plans• makes control decisions (analyze, decide, execute) for risks• authorizes expenditure of resources for mitigation• assigns or changes responsibility for each risk and mitigation plan• handles communication with the project manager• initiates trade studies or other research as needed
Project Manager	<ul style="list-style-type: none">• Acts as the chair of the JRMB• Final authority on the membership and decisions from the JRMB

4.0 TECHNICAL DETAILS OF THE RISK MANAGEMENT PROCESS

This section will be expanded in the future to provide the CRM process details and related procedures, methods, tools (e.g. PRAs, FTA, FMEA) and metrics. The process for continual assessment of the Project risk profile will be included, as well as, how the Planning and Scheduling Team will incorporate risk information into their schedules and networks, such as trigger points, descope options, etc.

As this is an evolving process, the risk likelihood and consequence scales (Section 1.2.2, Ref.1) discussed below might potentially be refined and additional scales (e.g., performance, operability, commercial viability, opportunity) added if needed.

In accordance with standard RM process (Section 1.2.2, Ref.1):

1. The likelihood or probability scales will be retained as nominal scales (that is, using the letters A-E) and will not be converted to a numerical value representing probability. Converting nominal scales to numerical scales (such as 1-5) introduces error if the original probability scale has not been calibrated.
2. Given the above policy, it is not required to multiply the likelihood scale and one or more of the consequence scales to give a single number reflecting net risk exposure. The underlying principle that both the likelihood and impact scales should in some sense be multiplied to determine net risk exposure will be incorporated into the placement of each risk into a single cell of a 5 x 5 matrix. In this matrix, the dimensions of likelihood and consequence are both represented. The likelihood scale is used for the vertical axis, with least likelihood at the bottom, and the consequence scale is used for the horizontal axis, with the lowest impact to the left. In this way, the lower left cell represents the lowest net exposure, and the upper right, the highest exposure. Use of such a matrix removes any need to perform an artificial numerical product of the two scales. Subsets or “zones” of the total set of 25 cells of the matrix can be rated with different levels of risk impact, such as low-medium-high, or low, low-medium, medium, medium-high and high. Such assignments of zones should be symmetric about the bottom left to top right axis. The initial matrix that will be used in JWST Risk Management is described below in Section 4.1.
3. Time Frame is assigned to each risk. This is the time by which action must be taken to mitigate the risk. On JWST, the time frame will be pre-defined as follows:
 - A risk is **near-term** if the Project must take action or will be impacted by the risk in the next 90 days.
 - A risk is **mid-term** if the Project must take action or will be impacted by the risk in the next 90-180 days.

- A risk is **far-term** if the Project need not take action or will not be impacted by the risk in the next 180 days.

4.1 RISK PRIORITY MATRIX

Figure 4-1 displays a matrix of priorities for individual risks, as a function of their independent likelihoods and consequence levels. This matrix will be used in the initial risk identification and analyses processes for the JWST Project.

4.2 RISK LIKELIHOOD LEVELS

Table 4-1 (below, will be used as an initial standard in the JWST Risk Process for assigning Risk Likelihood Levels. Note that the likelihood level scale is deliberately constructed to be non-numeric to avoid errors if original probability scale is not calibrated.

4.3 RISK CONSEQUENCE LEVELS

Table 4-2 is used as an initial standard in the JWST Risk Process with Table 4-1 for assigning Risk Consequence levels. Like the likelihood scales, the Consequence Level scale is non-numeric and is used directly together with the Likelihood value for a risk to determine the risk probability, using Figure 4-1.

L I K E L I H O O D		Consequence Level				
		A	B	C	D	E
	Very High: 80-100% Probability; Nearly certain	E	L	M	H	H
	High: 60-80% Probability; 2 chances in 3	D	L	M	M	H
	Moderate: 40-60% Probability; 1 chance in 2	C	L	M	M	H
	Low: 20-40% Probability; 1 chance in 3	B	L	L	L	M
	Very Low: 0-20% Probability; 1 chance in 10	A	L	L	L	M
Technical		Very Low	Low	Medium	High	Very High
		Minimal or no impact to mission success criteria or margins	Minor impact To mission success criteria, but can handle within established margins	Moderate impact To mission success criteria, but can handle within established margins	Major impact to mission success criteria, still meet minimum success criteria, threatens margins	Loss of life, vehicle., spacecraft, or can't meet minimum mission success criteria
Schedule		Minimal: little impact to schedule reserve; no impact to critical path	Minor: can handle within schedule reserve; no impact to critical path	Moderate: Impact to critical path, but can handle within schedule reserve; no impact to milestones	High: significant impact to critical path and can't meet established lower level milestone	Very High: major impact to critical path and can't meet major milestone
Cost		<2%	2-5%	5-7%	7-10%	>10%

Figure 4-1. Risk Priority Matrix

Table 4-1. Risk Likelihood Levels

Likelihood Level	Likelihood of Risk Occurrence
A	Extremely Remote
B	Remote
C	Unlikely
D	Likely
E	Highly Likely

Table 4-2. Risk Consequence Levels

Consequence Level	Technical Performance Impact	Schedule Impact	Cost Impact*
A	Minimal or None	Minimal or none	Minimal or none
B	Some margin reduction	Additional resources required to meet need date	<5%
C	Significant margin reduction	Minor slip in need date	5 to 7%
D	No margin remaining	Major slip in key milestone	7 to 10%
E	Below requirement	Unrecoverable Project delay	>10%

* The % refers to the Product Team's allocated budget.

4.4 RISK COMMUNICATION AND RISK MANAGEMENT TOOL

This section briefly considers the general subject of risk communication, the final element of the six-step Risk Management model shown in Figure 2-1. It is concerned with two interrelated topics: (1) communication of risk information at all levels in the Project and what inhibits or strengthens such communication, and (2) the specific ways that risk data on JWST will be collected, documented and distributed in order to facilitate effective communication, provide continuity to the Risk Management Process, and to anchor it in an explicit, accountable, and detailed manner.

Release of all technical data within this RMT to ESA and CSA (and related entities) must always fall within the context of the responsibilities in the NASA ESA and NASA CSA MOUs.

The basis for consistent, effective and comprehensive risk communication is a database of Project risks, accessible to all members of the Project Team. Some of the requirements that must be met by this system are:

- Information must be internally consistent and changes must be tracked effectively;
- Sufficient information must be available for each risk such that an individual not directly connected with its original formulation can gain sufficient understanding of its origin and consequences so as to be able to participate in its resolution;
- Risk information must also be secure from unauthorized alteration, as well as damage or loss, and from exposure to unauthorized individuals;
- Data elements that are subject to be modified by particular individuals must be clear;
- Reports must be consistent and self-explanatory;
- Risk information should be accessible over the network;
- Data entry of new information should be easy and straight-forward, with an easy-to learn user interface;
- Status of a risk at any point in time must be unambiguous;
- Priority information must be directly connected to the other risk elements; and
- A sufficient number of tailored reports corresponding directly to the expressed needs of users of the system.

As stated above, these statements can be taken to describe several of the top-level requirements for the RMT, available through the JWST internal website (<https://ngst1.hst.nasa.gov/>). The tool is used for creation, storage, and handling of a Risk List. The RMT is used for all six stages of the life cycle of a risk. The User's Guide for the Risk Management Tool (JWST-HDBK-001773) is available to the users through the JWST Project Library and the JWST internal website.

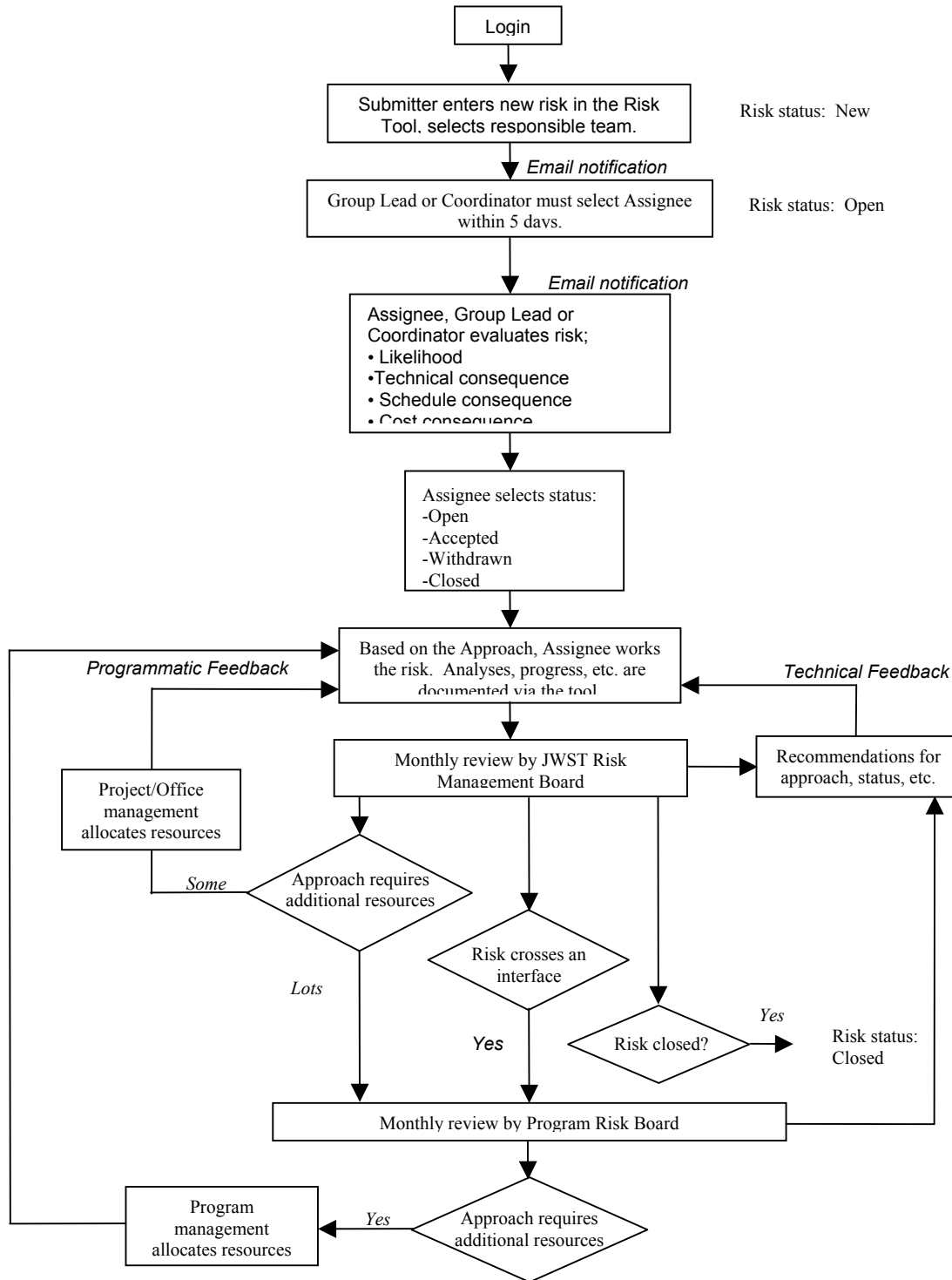


Figure 4-2. RMT Flow

APPENDIX A. ABBREVIATIONS AND ACRONYMS

<u>Abbreviation/Acronym</u>	<u>Definition</u>
CCB	Configuration Control Board
CMO	Configuration Management Office
CRM	Continuous Risk Management
CRMP	Continuous Risk Management Plan
CSA	Canadian Space Agency
DOD	Department of Defense
ESA	European Space Agency
FMEA	Failure Modes and Effects Analysis
FTA	Fault Tree Analysis
GPG	GSFC Procedures and Guidelines
GSFC	Goddard Space Flight Center
HQ	Headquarters
ICD	Interface Control Document
ID	Identification
IRD	Interface Requirement Document
ISIM	Integrated Science Instrument Module
ISO	International Standards Organization
ITAR	International Traffic In Arms Regulations
LOA	Letter of Agreement
MDR	Mission Definition Review
MOU	Memorandum of Understanding
MSR	Monthly Status Review
NASA	National Aeronautics and Space Administration
JWST	James Webb Space Telescope
NIAT	NASA Integrated Action Team
NPG	NASA Procedures and Guidelines
JRMB	JWST Risk Management Board
PRA	Probabilistic Risk Assessment
RMT	Risk Management Tool
RQMT	Requirement
RWG	Risk Working Group
SAM	Systems Assurance Manager
SATC	Software Assurance Technology Center
SET	Systems Engineering Team
SOW	Statement of Work
TRL	Technical Readiness Level